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ACCESS CONTROL DEVICES AND SYSTEMS INCLUDING SAME

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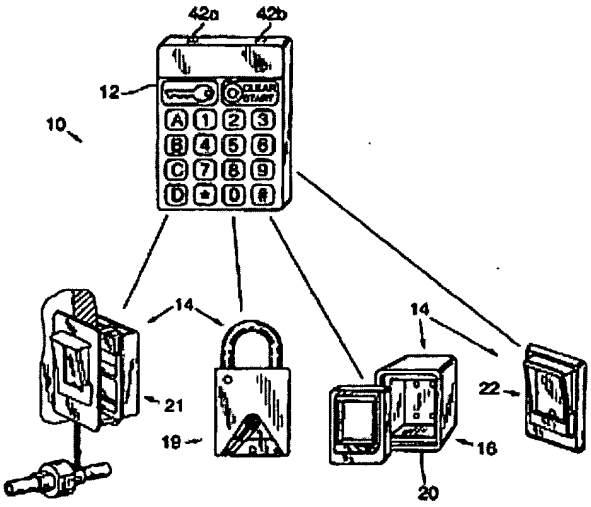
Abstract of **WO9725503**

Security systems (10) are provided in which a plurality of different lock devices (19, 21, 20, 22) are all responsive to a single key (12). Outdoor lock devices (19, 21, 20, 22) which may not be used for a period of years are unlocked by the key (12) in cooperation with a manually-applied unlocking force (74). A key nest (22) is provided which can controllably apply an unlocking signal to any electronically-controlled device.



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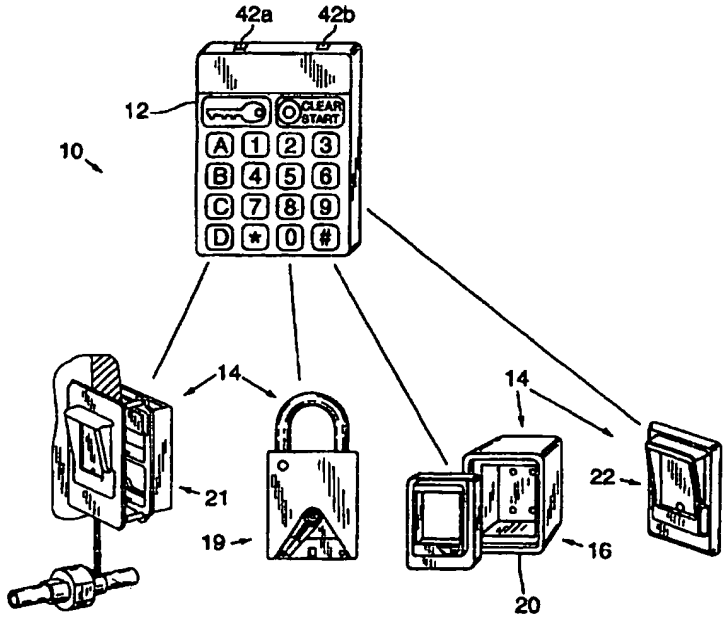

(57) Abstract

Security systems (10) are provided in which a plurality of different lock devices (19, 21, 20, 22) are all responsive to a single key (12). Outdoor lock devices (19, 21, 20, 22) which may not be used for a period of years are unlocked by the key (12) in cooperation with a manually-applied unlocking force (74). A key nest (22) is provided which can controllably apply an unlocking signal to any electronically-controlled device.

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ACCESS CONTROL DEVICES AND SYSTEMS INCLUDING SAME

Related Application Data

This application claims priority from Provisional Application No. 60/009,920, by Larson, filed January 12, 1996, entitled "Electronic Padlock Assembly."

Field of the Invention

The present invention relates to electronic access control devices and systems employing same, including those wherein different types of devices can be accessed by a common electronic key, and those wherein certain locking devices are adapted for extended periods of non-use in an outdoor environment.

Background and Summary of the Invention

The field of electronic access control is a mature one, with several distinct classes of systems.

One class of electronic access control system is commonly used in hotels and includes a plurality of guest room door locks operated in conjunction with a control station, often at the front desk. The door locks are powered either by an internal battery or by central wiring, but generally are not otherwise connected to the control station. In use, the control station is used to program an access card (often a magnetic stripe card) with data enabling it to access a particular door lock. In some systems, when such a card is first used with a door lock, the card/lock interaction serves to reprogram the lock so that it will no longer respond to the magnetic stripe card of an immediately-preceding occupant. In this manner, some limited reprogramming of such locks can be accomplished. Additional reprogramming can be accomplished by an accessory programming device which can be taken door-to-door and interfaced with each lock to alter certain instructions or data therein.

In one variant of the foregoing system, each door lock may be wired or otherwise coupled to the central control station. In another, plastic "punch" cards may be employed instead of magnetic stripe cards.

Exemplary hotel access systems are shown, e.g., in U.S. Patents 5,422,634, 5,397,884, 4,811,012, 4,760,393, and 4,614,862.

Another class of electronic access control system is the CardKey system and its competitors, used at industrial facilities and the like. In such systems, doors throughout the facility are equipped with electronically-releasable latches. When a person desires access through such a door, an access card is held next to a reader. The reader interrogates the card and, if it is found to be valid, momentarily actuates the door latch to allow passage. (In some systems, the user is additionally required to enter a personal identification number on a keypad associated with

the lock.) The reader is generally wired to a central control station so that a log identifying persons passing through each door can be maintained. Power to operate the readers and the door latches is generally provided through central wiring. Examples of such systems are more particularly detailed, e.g., in U.S. Patents 3,958,105, 3,970,824, 4,142,674 and 5,093,861.

Yet another class of electronic access control system is the Supra Advantage Express system and other electronic real estate lockbox systems. In such systems, thousands of identical lockboxes are mounted on houses listed for sale within a geographical area. Each contains the key to the house with which it is associated. The lockboxes can be opened by keys carried by real estate agents. In operation, a real estate agent first enters a personal identification number on a key to activate it, and then engages the key with a lockbox to gain access to the house key contained therein. Both the key and lockbox have memories in which details of the access are logged. This data can later be transferred to a central database, e.g. over a telephone line using an audio transducer in the key, to track lockbox accesses throughout the system. In most such systems, power to operate the lockbox is provided from the key. Additional details on such systems are found in U.S. Patents 4,777,556, 4,800,255, 4,851,652, 4,864,115, 4,967,305, 5,046,084, 5,090,222, 5,280,518, 5,475,375, the disclosures of which are incorporated herein by reference.

Each of the foregoing electronic security systems is tailored for a particular application, and serves that particular application well. Many other applications, however, have not been addressed by the electronic security industry.

Consider a power company. It may have distribution stations throughout a state -- each enclosed within a fence secured by a padlock. A lineman crew needing to access these distribution stations must have a key to each padlock (or a single key if the padlocks are commonly keyed). But this raises the specter of the power stations becoming accessible to anonymous ne'er-do-wells if this key is lost or duplicated. Despite the prevalence of such outdoor padlocks, and the long-known availability of electronic security systems, no one has applied electronic security technology to this application.

Consider also a fire department. When summoned to a building after-hours by a fire alarm, firemen must generally break down a door to gain access to the building. Once in, they may need to have keys to gain control of the building's elevators.

To avoid the need for breaking down the door, and to supply needed elevator keys and the like, some municipalities require that building owners mount an exterior vault high on the building (accessible only by ladder) containing keys for use by fire department personnel. Such vaults, in the past, have been secured by mechanical locks, opened by a conventional master key. Again, despite the widespread use of such fire department vaults for many years, and the long-

known availability of electronic security systems, no one has applied electronic security technology to this application.

One problem posed by each of the foregoing applications is that the lock may rest, unused, for a period of years. With the temperature extremes of outdoor environments, coupled with the tendencies of weathered lubricants to lose their effectiveness over a period of years, the locking mechanism may tend to stick in the locked position. Since battery-powered locking systems can provide only limited actuation forces (i.e., unlocking forces), battery-powered locks may have been considered unsuitable for such applications. Moreover, batteries age and can become unusable in outdoor environments. Further, the battery must be quite large for carrying sufficient energy to operate when the locking mechanism is affected by snow and ice.

Consider further a watchman at a large industrial site. In the course of his rounds, the watchman may need to access a multitude of different security devices including interior door locks, exterior door locks, outside padlocks, etc. While some doors may be accessible by a CardKey or similar system, such a key cannot be used with, e.g., padlocks. So the watchman is required to carry a large collection of mechanical and/or electronic keys.

A similar situation arises in the case, just discussed, of a power company lineman. In addition to accessing padlocks securing fence gates, a lineman may need to unlock equipment vaults, building doors, and accessories on power company trucks (e.g. controls for a cherry picker arm). Again, each generally requires its own key; a common electronic key for all these access devices has not generally been thought possible.

Other situations in which electronic access control systems might be advantageously employed, but haven't been, include: after-hours janitorial services which need access to many different doors, armored car locks, water district employees who need access to remote roads and water gates, businesses in which usual field service personnel are on strike, necessitating access by management or temporary help; cellular phone company maintenance workers who need access to third party sites in order to maintain transmitter equipment; night delivery services which need to access customer premises to make deliveries; elevator service technicians making after hours calls, etc., etc. Generally, the diversity of these different applications, and the different locks encountered in each, is believed to have contributed to the persistence of these needs.

One hindrance to meeting many of the foregoing needs has been the unavailability of suitably secure electronic padlocks -- especially those adapted for extended periods of non-use in outdoors environments.

The security problems with prior art padlocks generally concern their latch mechanisms. Latch mechanisms employing electromagnets are susceptible to magnetic fields which can be induced by holding magnets close to the lock. A magnetic field of sufficient magnitude can cause the padlock to release. As a result, extra measures such as added shielding must be added to the lock, at added expense.

Padlocks employing solenoid-activated release mechanisms are susceptible to release by applying an impact, such as a hammer blow, to the lock. Solenoid-activated release mechanisms are also susceptible to externally induced magnetic fields.

If left unused for several years in an outdoor environment, electronic padlocks tend to stick, making them unreliable. This is generally due to lack of motive power (whether from a motor, a solenoid, an electromagnet, etc.) sufficient to activate a release mechanism made sluggish by aging of lubricants, ice, foreign matter, etc.

In accordance with a preferred embodiment of the present invention, the foregoing and additional drawbacks of the prior art are overcome.

According to one aspect of the invention, outdoor lock devices which may not be used for a period of years are unlocked by an electronic key in cooperation with a manually-applied unlocking force.

According to another aspect of the invention, security systems are provided in which a plurality of different lock devices are all responsive to a single key.

According to another aspect of the invention, a key nest is provided which can controllably apply an unlocking signal to any electronically-controlled device.

The foregoing and additional features and advantages of the present invention will be more readily apparent from the following detailed description, which proceeds with reference to the accompanying drawings.

Brief Description of the Drawings

Fig. 1 shows an exemplary security system according to one embodiment of the invention, employing a plurality of different lock devices operable by a common electronic key.

Fig. 2 shows a block diagram of the key shown in Fig. 1.

Fig. 3 shows a block diagram of an electronic lock device, such as the vault shown in Fig. 1.

Fig. 4 shows an exploded view of a lid component of an exterior vault embodying a manual unlocking feature according to an embodiment of the present invention.

Fig. 5 is a front cutaway view of the lid component.

Fig. 6 is a back cutaway view of the lid component.

Figs. 7-9 are plan, top and side views of an electronic padlock embodying a manual unlocking feature according to another embodiment of the present invention.

Fig. 10 is a section view of the electronic padlock of Figs. 7-9, taken along line 10-10 of Fig. 9.

Fig. 11 is an enlarged excerpt of Fig. 10, showing the components in a different position.

Fig. 12 shows an exploded view of an electrified lock set which can be operated in accordance with the principles of the present invention.

Fig. 13 is a block diagram showing data flow between certain components of an illustrative embodiment.

Detailed Description

Referring to Fig. 1, an exemplary access control system 10 according to one embodiment of the present invention includes an electronic key 12, and a plurality of electronic devices 14 which respond to key 12. Illustrated devices 14 include an outdoor vault 16, an outdoor padlock 19, an electrified lockset device 21, and a key nest 22. (It should be understood that the illustrated devices 14 are exemplary only, and in other systems according to the invention other devices can be used.) A feature characterizing the illustrated system 10 is that a collection of disparate devices 14 all cooperate with a common key 12.

Key 12 serves not only as an access key for each of devices 14, but also serves as a data link -- relaying data to and from devices 14. In some respects, the devices 14 may be viewed as terminals of a network, with key 12 serving as the hub. Such a perspective may view system 10 as a key-centric network.

Moreover, for many devices 14, key 12 also serves as the operative source of electrical power.

As shown in Fig. 2, illustrated key 12 includes a keypad 24, a CPU 26, RAM and ROM memories 28, 30, a primary battery 32, a calendar/clock circuit 34, a piezoelectric transducer 36 with associated modulator 38, and a communications interface 40. The illustrated communications interface employs two electrical contacts 42a, 42b, but other coupling arrangements (e.g., more than two contacts, inductive coupling, optoelectronic coupling, etc.) can alternatively be used. In other embodiments, key 12 can include a small alphanumeric display (e.g., LCD) and/or one or more indicator lights (e.g., LEDs).

Contacts 42a, 42b are used to connect to corresponding elements on a device 14. Illustrated interface 40 bidirectionally couples data signals between the key 12 and device 14 in the form of modulation on a power signal provided from the electronic key 12 to device 14.

CPU 26 can be an Intel microcomputer (e.g., 80C52) which controls operation of the key according to programming instructions permanently stored in ROM 30. The calendar/clock circuit 34 provides data corresponding to the year, month, day, and time.

The illustrated RAM 28 is comprised of a small RAM memory inside the calendar/clock circuit 34, together with 2 EEPROMS, the latter of which can store 2048 (2K) 8-bit bytes of data.

Transducer 36 is used to provide audible feedback to the user signalling a variety of key conditions. The transducer is also used for frequency shift keyed relaying of data from the key to external devices (e.g. through an audio telephone circuit).

Battery 32 comprises three AAA cells which provide power to the key circuitry and, through contacting elements 42, to devices 14 as well. An auxiliary battery 35 or storage capacitor (not shown) can be employed to provide power to the calendar/clock circuit 34 when battery 32 is removed and replaced.

Additional information on key 12 can be found in U.S. Patent 5,280,518 hereby incorporated by reference, and in the appendices.

Desirably, key 12 is constructed in a trim polycarbonate enclosure sized to fit conveniently in a user's pocket.

One representative type of lock device 14 is an outdoor vault 16. The vault body 20 may be that of a conventional exterior vault, such as is available from The Knox Company of Irvine, California, for containing building access keys for fire department and emergency personnel.

Referring to Fig. 3, circuitry 48 in the lid 18 of vault 16 includes a CPU 50, a memory 52, an actuator 88, and a communications interface 56. The illustrated communications interface 56 employs two electrical contacts 58a, 58b, that are exposed in the top of the bezel 70 of the lid, described more below. Other coupling arrangements (e.g., more than two contacts, inductive coupling, optoelectronic coupling, etc.) can be used. The illustrated vault lid 18 additionally includes an indicator LED 60.

Fig. 4 shows an exploded view of lid 18. As illustrated, lid 18 includes a back cover 62, a pair of cooperating lock blades 64, a chassis 66, a base 68, and a bezel 70.

The outer edges of the lock blades 64 define tabs 72 that normally extend beyond the sides of lid 18 and serve as locking members or bolts that fit into correspondingly shaped openings in the side of the vault body 20 to secure the lid in place on the body. Elevator keys or the like may be stored inside of the vault 20. Preferably, the lid 18 is attached to the body 20 via a cable or chain.

Movement of the lock blades 64 toward each other retracts the tabs 72, thereby allowing the lid to be removed from the body. Such movement of the lock blades is effected by turning a thumb lever 74, as detailed below.

Interposed between the cover 62 and the lock blades 64 are a printed circuit board bumper 76, a printed circuit board 78, and a lock blade cover 80. Printed circuit board 78 contains the circuitry 48 discussed above in connection with Fig. 3, except for actuator 88. The circuit board 78 is fastened by screws to backwardly protruding (i.e., to the left in Fig. 4) posts 67 integrally formed with the chassis 66. The lock blade cover 80 is a rigid plate that is fastened by a shoulder screw 81 extending through a central aperture and into a threaded central

hub 69 on the chassis 66. The lock blade cover 80 bears against the back-facing surfaces of the lock blades to ensure that the motion of the lock blades generally remains in a single plane.

As best shown in Fig. 6, the inner ends of the lock blades 64 terminate in legs 65 that are configured and arranged about the central hub 69 in the chassis so that the motion of the lock blades 64 is restricted to limited translational motion for extending and retracting the tabs 72.

Interposed between lock blades 64 and chassis 66 is a tie plate 84. The tie plate 84 is a generally elongate member having a clear central aperture 128 through which the shoulder screw 81 passes. As a result, the tie plate is rotatably mounted to the chassis 66 about hub 69 and resides within a recess formed in the back surface of the chassis 66.

The tie plate 84 carries at each end a bushing 82 that protrudes from the chassis recess and fits within a slot 130 formed in a lock blade 64. As best shown in Fig. 6, the long axis of the slots 130 are oriented to be angled relative to the direction of movement of the lock blades 64 so that clockwise (with respect to Fig. 6, counterclockwise with respect to Fig. 5) rotation of the tie plate 84 effects a limited cam (tie plate) and follower (lock blades) action such that the rotational movement of the tie plate is transferred to the translational sliding of the lock blades to retract the tabs 72.

The mechanisms for effecting rotation of the tie plate (hence, retraction of the lock blades) include a link 95 that is carried on the front of the chassis 66. One end of the link 95 carries two posts, one of which, 126, receives the end of an extension spring 94. The other end of the extension spring 94 is hooked to a post on the chassis 66, thus the link is normally urged by the spring 94 upwardly (Fig. 6). The other post 127 in the end of the link pivotally fits into a hole 129 formed in the tie plate 84 at a location eccentric to the central aperture 128.

The other end of the link 95 includes a hook 96 that normally rides along the external surface of a code wheel 104. The code wheel 104 is rotatably mounted between the base 68 and the front of the chassis 66. More particularly, the code wheel 104 is a generally annular-shaped member having a central sleeve 103 that receives one end of a pivot lock 110 that fits through a hole in the base 68. That end of the pivot lock 110 is generally cylindrical except for a flat that engages a flat formed inside the sleeve 103 so that the pivot lock is keyed to the code wheel 104. A washer 108 is positioned between the pivot lock 110 and the base 68.

The outer radial surface of the code wheel 104 is continuous except for a gap 105 formed therein as best shown in Fig. 5.

A generally annular recess is defined in the back side of the code wheel between the sleeve 103 and the outer surface of the wheel. A torsion spring 102 fits within the recess. One end of the torsion spring is anchored within the code wheel and the other end of the torsion spring protrudes from the recess along a line parallel to the rotational axis of the code wheel 104. That end of the spring fits into a hole formed in a cover plate 100.

The cover plate 100 is a generally disc-shaped member having most of its outer diameter corresponding to that of the code wheel 104. More particularly, the outermost radial surface of the cover plate 100 is interrupted with an arcuate-shaped notch 107, best seen in Fig. 6. The cover plate fits around the sleeve 103 of the code wheel and generally encloses the recess within which the torsion spring 102 is carried. The cover plate is held in place by a snap ring 98 that engages the innermost end of the pivot lock 110 and the chassis 66. The cover plate is free to rotate somewhat about the sleeve relative to the pivot lock 110.

As best shown in Fig. 5, a compression spring 90 is fit within a recess in the chassis 66 and oriented so that it continuously urges the hook 96 of the link 95 to ride along the outer radial surfaces of the code wheel 104 and cover plate 100.

The cover plate 100 is movable relative to the code wheel 104 for alternately blocking and unblocking movement of the hook 96 into the gap 105 that is defined in the outer surface of the code wheel. In this regard, the torsion spring 102 normally urges the cover plate 100 to rotate into an orientation such that notch 107 in the outer radial surface of the cover plate is spaced from the gap 105 in the code wheel, thereby preventing the hook 96 from fitting within the gap 105. The back-facing surface of the cover plate 100 includes a projecting stop 109 that can be in abutting contact with one end of an actuator latch 92 for the purpose of permitting rotation of the code wheel 104 relative to the cover plate 100 so that the hook 96 can engage the gap 105 in the code wheel as described next.

The actuator latch 92 (a portion of which is broken away in Fig. 6 for clarity) is pivotally mounted to the chassis (shown as pivot point 93 in Fig. 6). One end of the latch includes a pivot pin 97 that fits into a transverse hole in a normally extending shaft 99 of a solenoid 88 that is mounted to the back of the chassis beneath the lock blades 64. The solenoid 88 comprises, in cooperation with the actuator latch 92, the actuator assembly for facilitating the application of manual unlocking force to the lid as will become clear.

Whenever the solenoid 88 is provided with a suitable electrical signal (which is derived from the electronic key 12 as mentioned above), the solenoid shaft 99 is retracted (to the right in Fig. 6) and pulls with it the pivotally attached pin 97 of the actuator latch. As a result, the opposing end of the latch 92 moves into a position (Fig. 6) for abutting the stop 109 on the cover plate. As a result, rotation of the pivot lock 110 and connected code wheel 104, which rotation is generated by manually applied force to a connected thumb lever 74 as described later, while the actuator is in the just-described position (which rotation appears clockwise in Fig. 6) moves the gap 105 of the wheel toward engagement with the hook 96 of the link 95. The stop 109 on the cover plate, however, will abut the latch 92 so that rotation of the cover plate 100 is halted with the notch 107 of the cover plate being generally adjacent the hook 96.

Continued turning of the code wheel 104 will move the gap 105 in that wheel next to the region of the notched part of the cover plate and adjacent the hook 96 so that the hook is

forced by the compression spring 90 to fit into the gap. When this occurs, further rotation of the code wheel 104 pulls the link 95 downwardly, thereby rotating the tie plate 84 for retracting the tabs 72 of the lock blades. The tabs 72 retract by an amount sufficient to remove them from the corresponding-shaped openings in the vault body 20 so that the lid 18 can be removed to expose the contents of the vault.

The back cover 62 and the base 68 are fastened together by screws 122. A gasket 106 is applied to the lid 18 and compressed between the vault 20 and lid when the lid is closed, thus sealing the entire vault interior from the outdoor environment. Inwardly protruding flanges 132 on the back of the base 68 serve to protect the sides of the components that are enclosed by the back cover. The flanges 132 also surround the extended tabs 72 of the lock blades when the lid is closed, thereby resisting bending or shearing of the lack blades that might otherwise occur as a result of an attempted forced opening of the vault by prying the lid from the vault. It will be appreciated, therefore, that the electronic components carried by the lid are normally housed within the sealed vault, protected from the outdoor environment.

Preferably, a bracket 133 protrudes from one flange 132 for the purpose of providing a mechanism for attaching the lid to one end of a cable that is also attached to the vault body.

The bezel 70 is anchored to the front of the base 68 by screws 120. Between the bezel and base is a thin plastic (polycarbonate) plate 111 that includes a flange 112 to which is mounted a small printed circuit board 114 that carries the above-mentioned contacts 58a, 58b. That board 114 also carries the LED 60. The flange and printed circuit board fit into a correspondingly shaped pocket formed by two spaced-apart walls in the upper end of the bezel 70. The innermost wall includes openings, one of which is shown at 115, through which protrude the contacts 58a and 58b for engagement with the contacts 42a, 42b of the key 12. Wires (not shown) between the board and the solenoid 88 deliver the electrical signal from the key to the solenoid for retracting its shaft as described earlier.

The thumb lever 74 is fastened via screw 118 through the bezel 70. The innermost end of the lever 74 engages the outer end of the pivot lock 110 so that rotation of the thumb lever 74 is directly transferred to the pivot lock 110. In a preferred embodiment, a detent spring 116 is fit between the bezel and the thumb screw to hold the thumb screw in a normal position such that a nest 124 defined by the bezel remains clear for receiving the key.

In operation, a key 12 is fitted into the nest 124 defined by the bezel. In this position, contacts 42a, 42b on the key engage with contacts 58a, in the 58b lid. Preferably, an electronic handshaking sequence then ensues, followed by a request from the key to access the lock.

If the vault CPU 50 determines that the key properly authorized entry to the vault body 20, the CPU causes an actuation signal to be sent to solenoid 88 and to the LED 60.

Solenoid 88 responds by pivotally moving actuator latch 92 into position for abutting stop 109 so that the hook 96 may engage the gap 105 in the code wheel 104, thus rotating the tie plate 84 to retract the lock blades, as described above, when thumb lever 74 is rotated.

It should be noted that the thumb lever 74 is shaped so that movement of thumb lever 74 to unlock the lid also serves to block removal of key 12 from the nest 124. Accordingly, the key cannot be withdrawn from the lid until the lid is again returned to its locked position (i.e., by counter-rotating the thumb lever).

It will be recognized that the opening procedure just detailed has two stages: a first low-force stage and a second high-force stage. The low force in the first stage is provided by the key-powered movement of the actuator latch. The high force in the second stage is provided by a human operator via manipulation of the thumb lever.

Another type of lock device 14 is an electronic padlock 19, particularly detailed in Figs. 7-11. As shown, padlock 19 includes a shackle 202 which can be removably fixed within body 201. A set of balls 204 slidingly engage slots 206 on shackle 202 to prevent relative movement between the shackle and the body 201.

A plug 205 slidingly engages balls 204 to prevent relative movement between balls 204 and slots 206. A pawl 207 has a dog-legged profile and defines a hole 226 at its top end through which a pin 221 is inserted, pivotably attaching plug 205 to pawl 207. The lower end of pawl 207 defines a hole 228 through which a drive pin 210 is securely fitted. A spring 214 rests on the shoulder of plug 205 on one end, and on the shoulder of pawl 207 and a retaining plate 222 on the other end. Spring 214 yieldably holds plug 205 in the position shown in Fig. 10, while forcing pawl 207 to rotate about pin 221 in a clockwise direction (as viewed in Fig. 10).

Referring to Fig. 7, a lever 203 is rotatably mounted to body 201 by a pivot pin 219. Referring to Fig. 10, pivot pin 219 engages a drive wheel 208 by means of a keeper pin 223. As lever 203 rotates within body 201, drive wheel 208 rotates, presenting a drive groove 209 to the drive pin 210. A motor 216 has a drive shaft on which a blocker wheel 215 is attached. Blocker wheel 215 has a transverse groove 217 shaped to receive pawl 207 when motor 216 is unenergized. When motor 216 is energized, blocker wheel 215 rotates, presenting groove 217 in a parallel relationship to pawl 207.

Pin 210, which rides on the outside radial surface of drive wheel 208 under spring load from spring 214, is prevented from engaging drive groove 209 during rotation of drive wheel 208 by blocker wheel 215, as shown in Fig. 10.

When motor 216 is energized, blocker wheel 215 rotates, presenting groove 217 in parallel alignment with pawl 207. Shackle 202 can then be released from balls 204 by rotating lever 203 from the clockwise position, as shown in Fig. 7, in a counterclockwise direction. Drive wheel 208 thereby drives groove 209 into alignment with drive pin 210, and spring 214 rotates pawl 207 until drive pin 210 rests in drive groove 209. Further rotation of drive wheel 208

draws plug 205 down against spring 214 until a chamfer 226 allows balls 204 to move from engagement with slots 206, as shown in Fig. 11. With balls 204 moved inward as shown in Fig. 11, shackle 202 is moved upward to a released position.

It will be recognized that the opening procedure just detailed has two phases: a first low force phase and a second high force phase. The low force in the first stage is provided by an electromechanical release mechanism. The high force in the second stage is provided by a human operator.

Padlock 19 has an opening 224 into which the end of the electronic key 12 is inserted, making contacts with metal contacts 225, Electronically, padlock 19 is essentially identical to vault lid 18, discussed above, except the actuator is a motor instead of a solenoid.

Yet another type of lock device 14 employs a conventional electrified lockset of the sort shown, e.g., in Fig. 12. The illustrated lockset device 21 includes a prior art product 300 commercially available from companies such as Schlage and Best Lock. To actuate lockset 300, circuitry of the sort shown in Fig. 3 is housed near the lockset for applying an unlocking signal to the lockset actuator only after the key and lock CPUs 26, 50 determine that such access is authorized. In this embodiment, the actuator 54 is a small relay through which a power signal is controllably applied to the lockset.

In the illustrated embodiment, this power signal is provided by a three, nine-volt batteries 325 housed within a compartment 326 of a box 321. The box is preferably secured to the interior surface of a door by screws 322 that are threaded into spacers 313 that pass through the door thickness. The spacers 313 are fastened to an exterior plate 309, which is thus held against the exterior surface of the door.

Preferably, the compartment 326 of the box, once mounted to the door, is substantially sealed. Access to the batteries is obtained through a removable lid 317 that is held against an opening in the box by threaded fasteners, with a gasket 316 to facilitate sealing the opening to the compartment.

With the batteries in place and connectors 324 attached, power for the lockset actuator, controllably applied as described below, is conducted via wires 305 to a male connector 314 that mates with a female connector 306 within which wires 304 from the actuator of the lockset 300 terminate via crimp-type terminals 305. Preferably, the wiring 304 is covered with heat-shrinkable tubing 302 for protection.

It will be appreciated by one of ordinary skill that by varying the length of the wire 304 the lockset device 21 may be placed at any convenient location, not necessarily adjacent the lockset 300. Preferably, the wires 304 between the lockset 300 and the lockset device 21 are enclosed, for example, by having those wires extend through the interior of the door. Preferably, the box 321 includes clamps 315 for securing the wire 305 thereto.

The printed circuit board 320 is fastened to the box 321 such that most of its components are housed within a lower compartment 327 formed in the box. The printed circuit board 320 contains the circuitry 48 discussed above in connection with the vault lid 18.

A bezel 370 is anchored to the front of the cover plate 309 by fasteners 308. Between the bezel and the plate is a thin plastic (polycarbonate) plate 311 that includes a flange to which is mounted a small printed circuit board 312 that carries the contacts 58a, 58b in a manner as discussed above in connection with the lid 18. Similarly, that circuit board 312 carries an LED, and the flange and the printed circuit board fit into a correspondingly shaped pocket formed in the upper end of the bezel 370. Wires 310 extend from the board 312 to connectors 321 on the main printed circuit board 320 for delivering the electrical signal from a key 12 to the circuitry carried on board 320 for processing to determine whether access is authorized and, if it is, for controlling the power signal to the lockset 300.

Finally, lock device 14 can be a key nest 22 (Fig. 1). The key nest is similar to that employed in the vault lid 18 and padlock 19 just discussed, and basically serves to receive the electronic key 12 and establish electrical contact therewith (through, e.g., a pair of metal contacts). Again in this case, the actuator 54 in circuitry 48 is a small relay used to control passage of an electrical signal therethrough. The nest 22 can be used with an electronic lock, in which case the electrical signal needed to open the lock can be routed through the relay.

This same approach -- a key nest 22 controlling a relay 54 through which an electrical signal is controllably applied to an external device -- can be extended to a great number of applications beyond locks, per se. An example is the utility truck cherry picker arm noted above. The relay can be interposed at various points in the controls for the cherry picker arm to prevent use of the arm until a properly authorized key is engaged in the nest 22. Other applications include controlling application of power to an electric gate or garage door opener, or to serve as a starter interrupter on a forklift. Indeed, whenever an electrical signal (power or otherwise) is to be controllably applied to an electrical device (whether AC or DC; high or low voltage), nest 22 can be utilized.

Moreover, there are some applications of key nest 22 in which an associated electrical device is not required. This occurs, for example, in providing checkpoints at which night watchmen register when patrolling a large industrial facility. By mating a key with the nest, a corresponding entry is made in both the key and lock access logs, confirming a particular watchman's presence at a particular key nest at a particular time on a particular date.

Fig. 13 gives an overview of the data flow between different components of the preferred embodiment. In addition to the key 12 and devices 14 discussed earlier, the illustrated system includes a telephone 152, a computer 154, and a programming base 156.

Operational details regarding the components shown in Fig. 13, and the features thereby provided, are set forth in the present assignee's issued patents incorporated by reference

above. Briefly, each access to a device 14 is recorded by storage of data indicating user, date and time, in memories of both device 14 and key 12. (The access memory 52 in device 14 stores data corresponding to the 35 most recent entries; the access memory 28 in key 12 can store data corresponding to 272 accesses.) Each user's key can be programmed to limit its use to a specific lock, a group of locks, or a geographic area. Each key can also be programmed to expire at a given interval (daily, weekly, etc.), requiring reauthorization (by entry of a renewal code) before further use. Lock devices 14, too, can be programmed, e.g., to recognize certain otherwise-authorized keys and deny them access (by a lockout list).

The keys and locks can be programmed in a variety of ways. One is by radio signals. Another is by a programming device (e.g., programming base 156 of Fig. 13) that mates with the locks/keys and relays the programming instructions thereto. Yet another is the viral propagation technique wherein updated instructions are passed between system components each time a lock device/key pair interact. All of the foregoing techniques are more fully detailed in the patents incorporated by reference.

A key 12 can retrieve access information from a lock's memory 52, and can then relay this data to a database in computer 154 by telephone 152 using audible DTMF signals. Computer 154 can be instructed, by DTMF or voiced instructions, to FAX a corresponding access report including each accessing key holder's name, date and time of access, company name/phone number, etc., to any desired FAX number.

Alternatively, access data can be retrieved from the key by engaging the key with the programming base 156 (Fig. 13).

Computer 154 is typically located at a central office and performs most of the administrative functions required of the system. As reviewed above, these include issuing renewal codes for the keys, establishing which keys are authorized to access which devices, establishing lockout lists, and receiving access log activity and generating reports corresponding thereto.

From the foregoing, it will be recognized that the preferred embodiment of the present invention overcomes numerous disadvantages of the prior art and provides comprehensive access control solutions well adapted for a number of diverse applications.

Having described the principles of our invention with reference to several preferred embodiments and variations thereon, it should be apparent that the invention can be modified in arrangement and detail without departing from such principles. Although the preferred embodiments have been described as including certain combinations of features, applicants' invention includes alternative embodiments that include other combinations of the features disclosed herein and in the documents incorporated by reference.

Accordingly, it should be recognized that the foregoing embodiments are illustrative only and should not be taken as limiting the scope of our invention. Instead, we claim as our

invention all such modifications as may come within the scope and spirit of the following claims and equivalents thereto.

WE CLAIM:

1. A security system comprising:

an electronic key, said key including means for logging access information in a memory therein, said key further including means for becoming automatically disabled by the passage of time unless timely re-enabled;

a first electronic lock; and

a second electronic lock, said second electronic lock being of a disparate variety than the first, both of said locks being responsive to said electronic key.

2. The security system of claim 1 in which said first lock is a lock device adapted for extended periods of non-use in an outdoor environment, said lock device including means for receiving operating power from the electronic key, said lock device further including a manually-operated member permitting the external application of a manual actuating force to unlock said device.

3. The security system of claim 2 in which said second lock device does not include a manually-operated member permitting the external application of a manual actuating force to unlock said device.

4. The security system of claim 1 in which at least one of said first and second locks is chosen from the group consisting of: padlocks, outdoor vaults, electrified door locksets, and mechanical lock covers.

FIG. 1

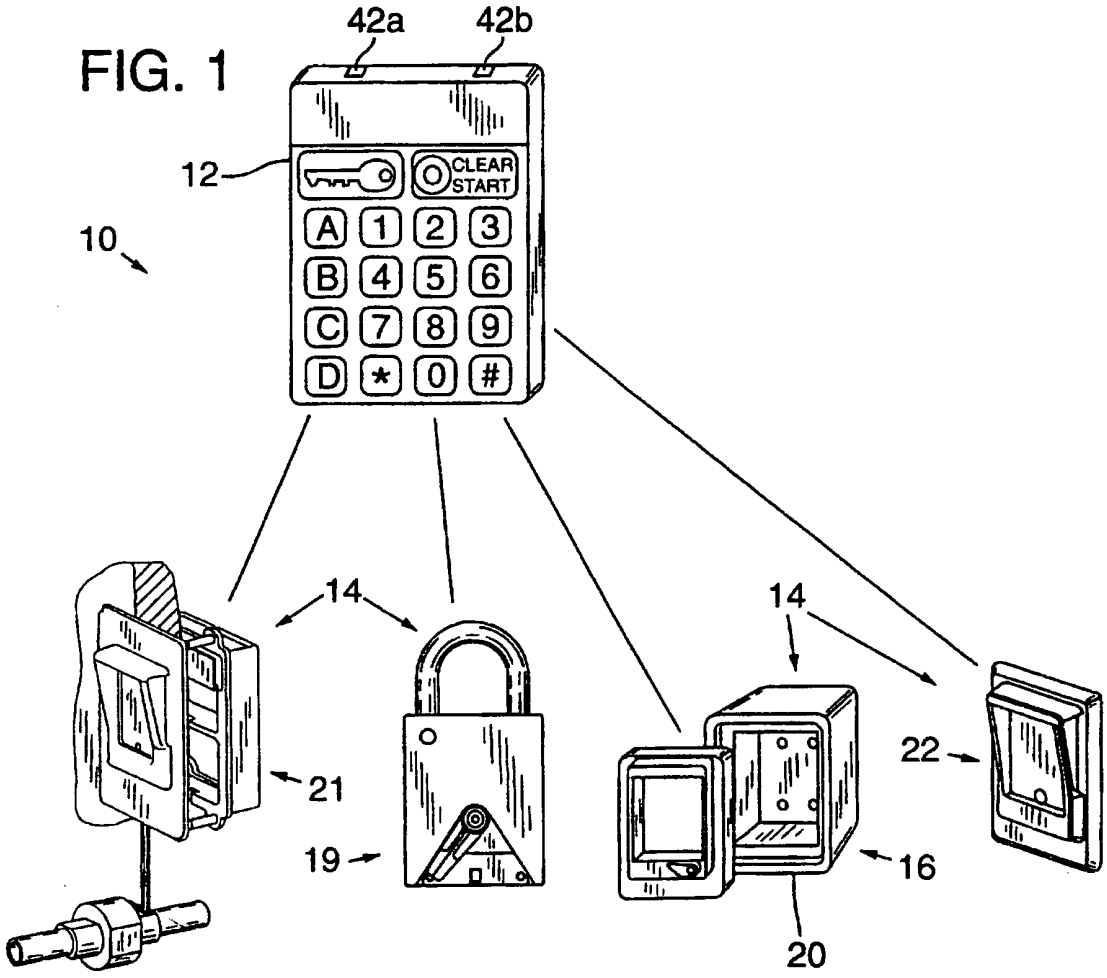

FIG. 2

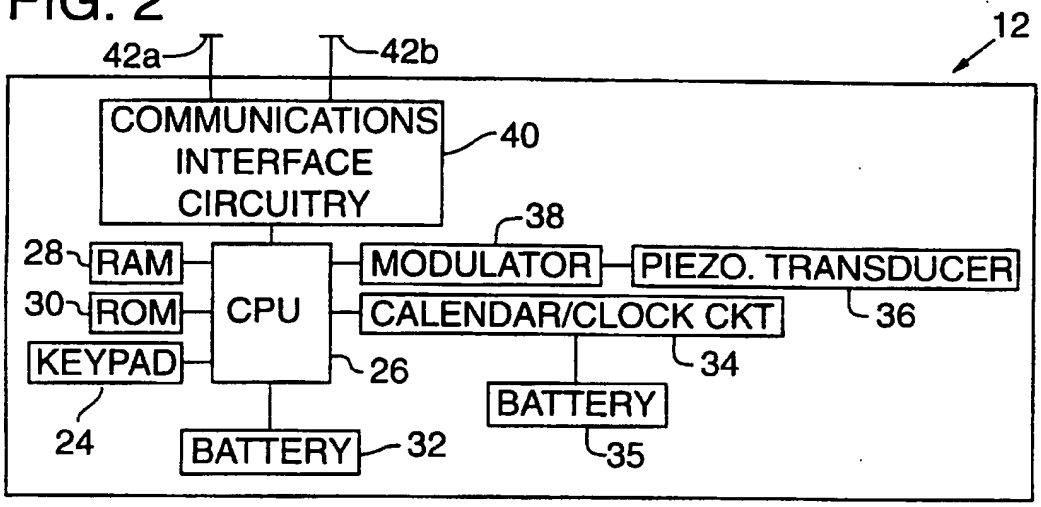
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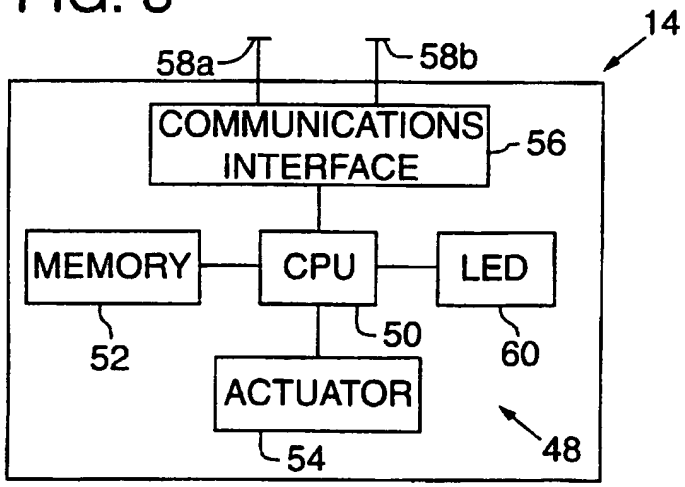
FIG. 3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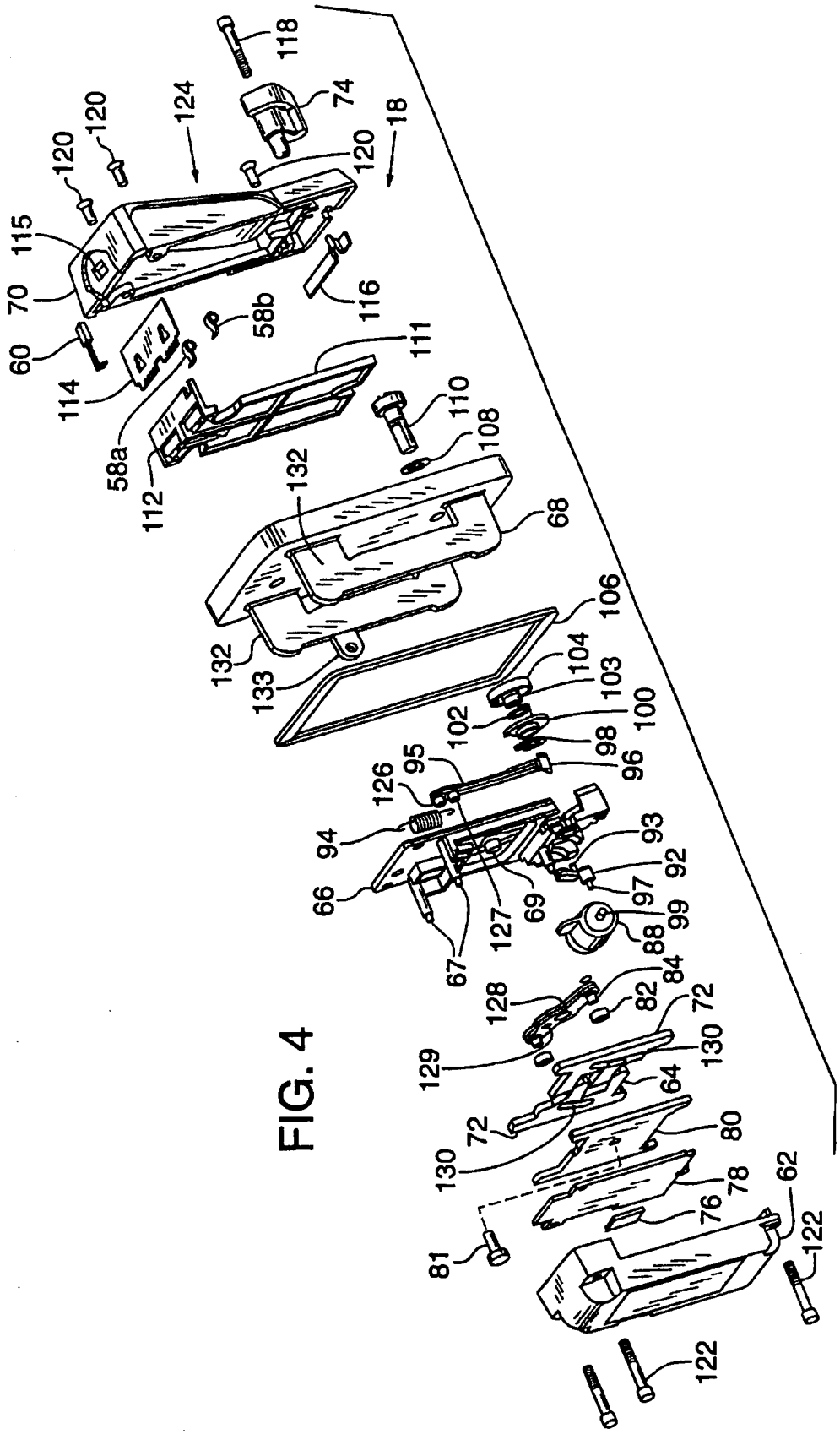
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FIG. 4

FIG. 5

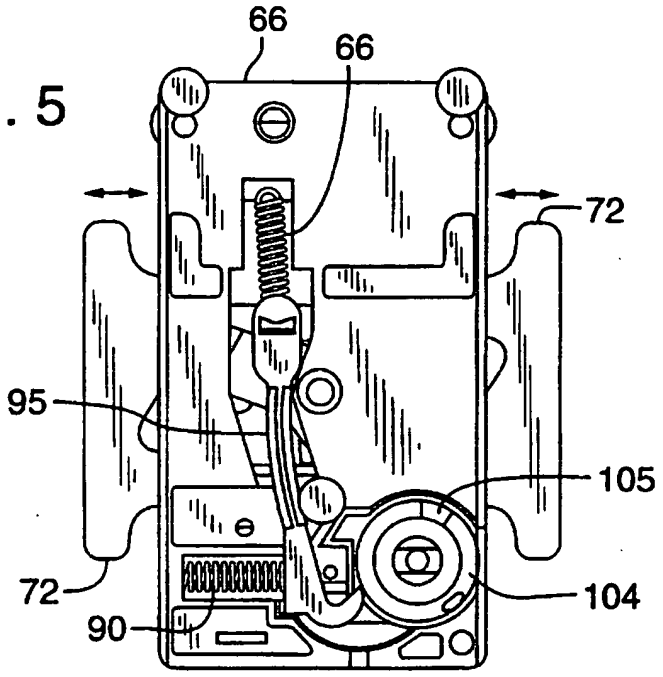
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FIG. 6

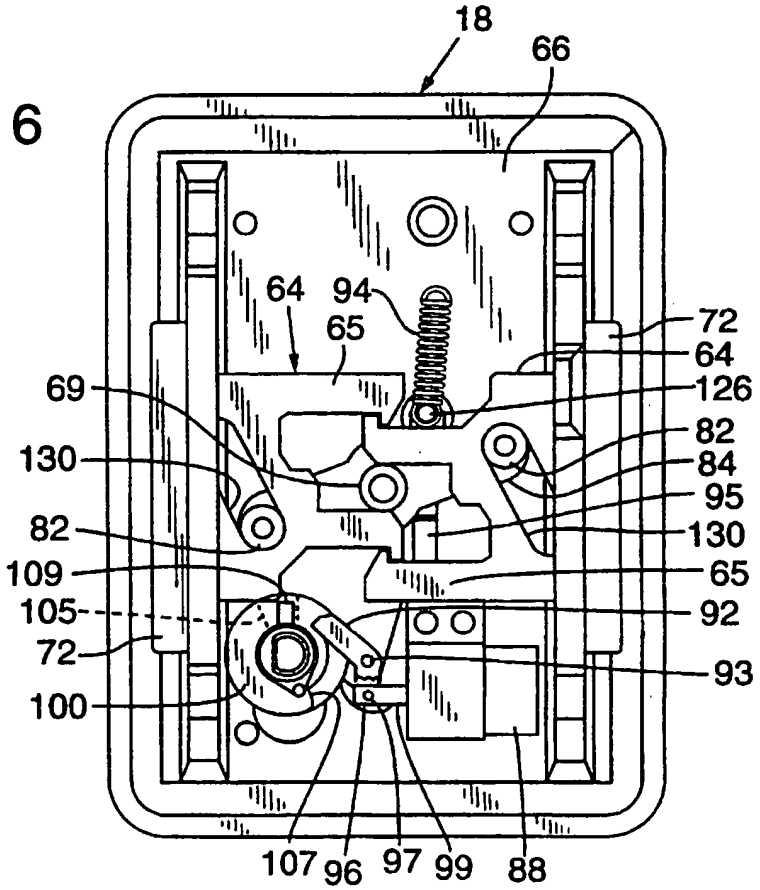
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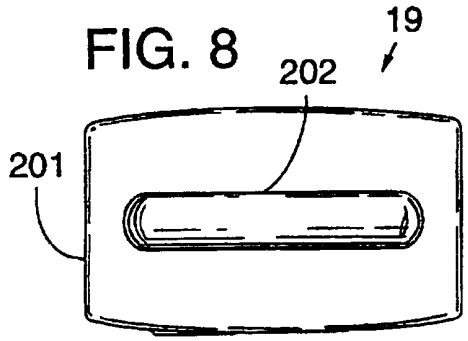
FIG. 8



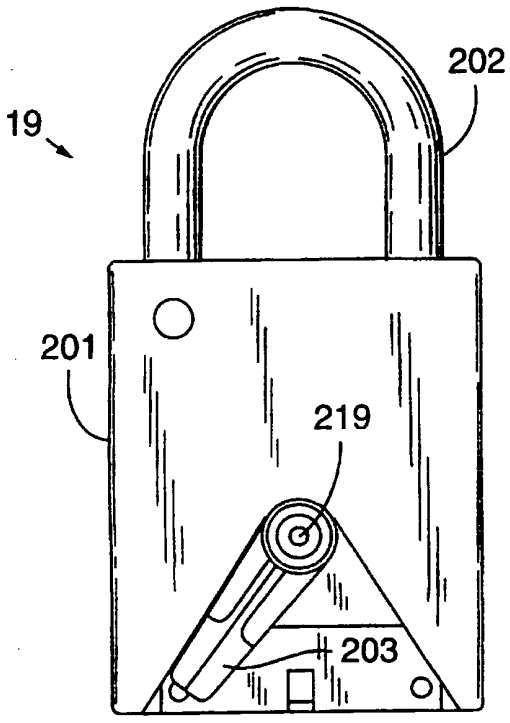


FIG. 7

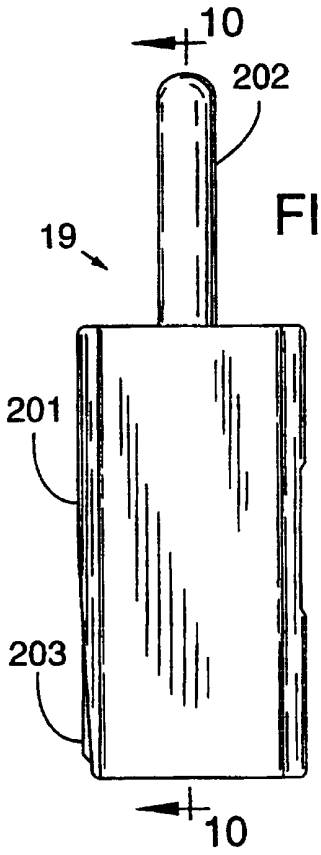


FIG. 9

FIG. 10

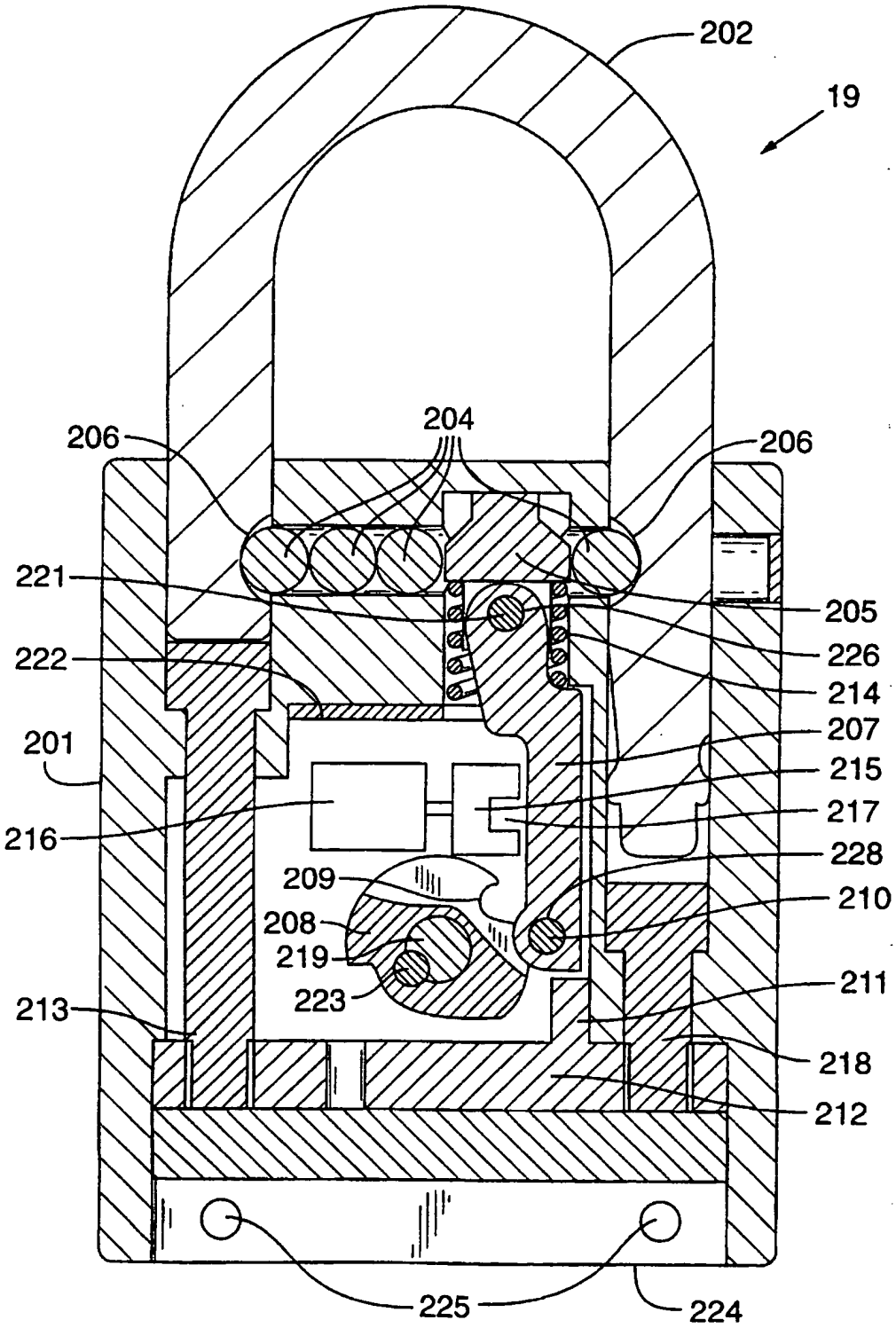

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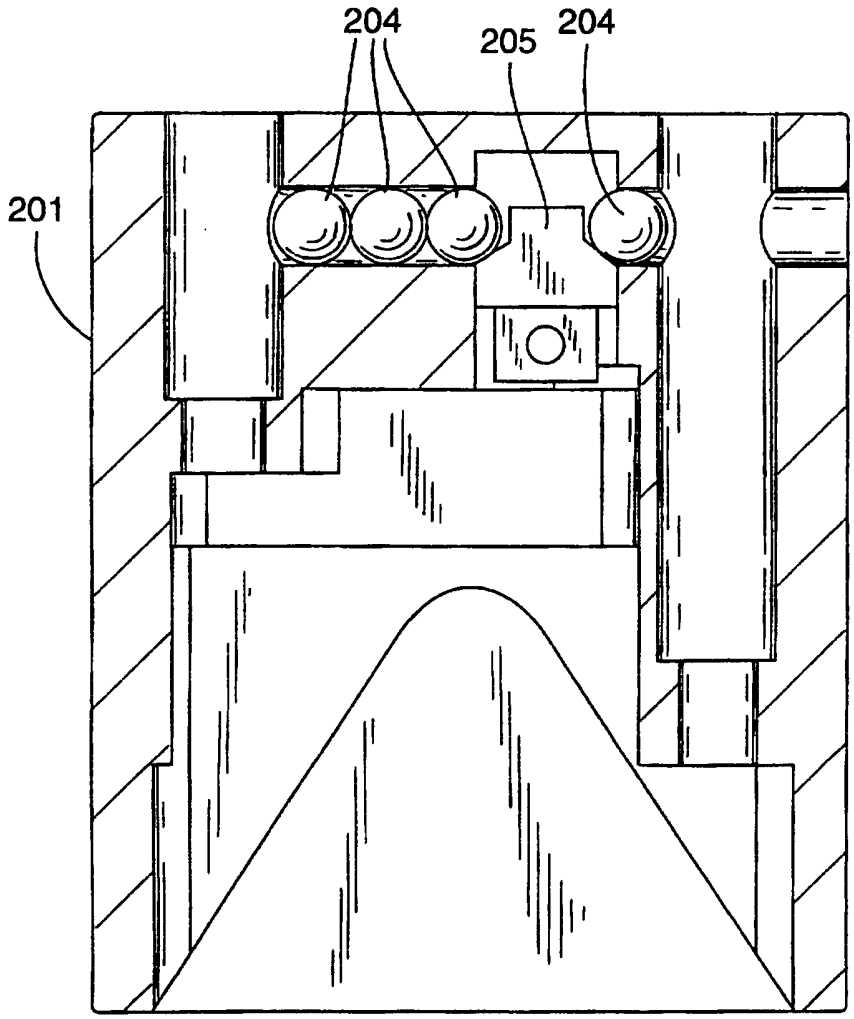
FIG. 11



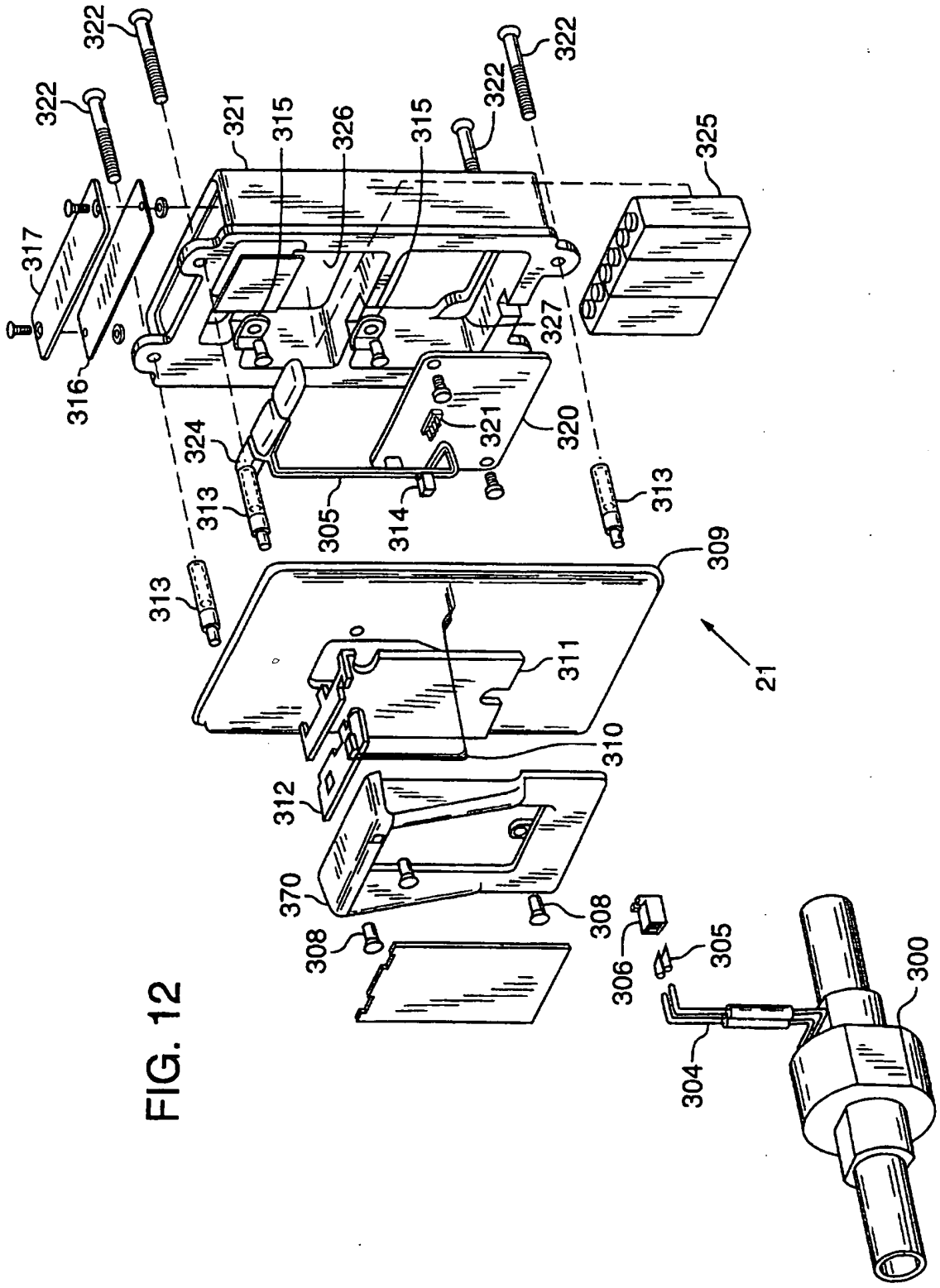

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FIG. 12

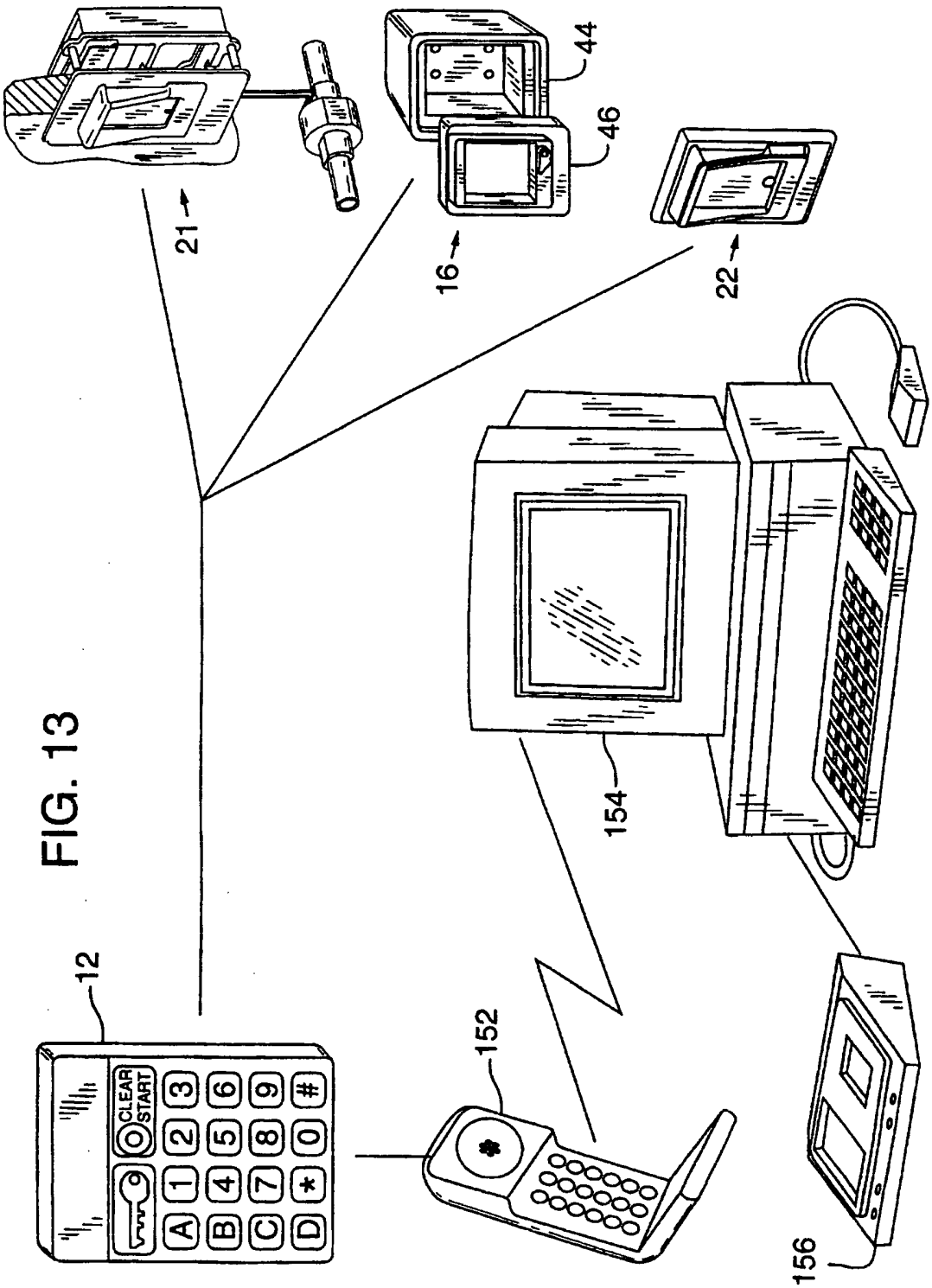

FIG. 13

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US96/20040

A. CLASSIFICATION OF SUBJECT MATTER
IPC(6) :E05B 49/00
US CL : 70/278
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 70/278, 283, 256, 257, 233, 63

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4,453,161 A (LEMELSON) 05 June 1984 (05/06/84), entire document	1-4
X	US 5,351,042 A (ASTON) 27 September 1994 (27/09/94), entire document.	1-4
A	US 5,046,084 A (BARRETT et al.) 03 September 1991 (03/09/91), col. 5, line 7 through col. 11, line 28.	4
X	WO 86/00108 A1 (HERRIOTT et al.) 03 January 1986 (03/01/86), entire document.	1-4
A	US 4,929,880 A (Henderson et al.) 29 May 1990 (29/05/90), col. 5, line 30 through col. 11, line 50.	4

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search 16 MARCH 1997	Date of mailing of the international search report 01 APR 1997
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer DARNELL M. BOUCHER Telephone No. (703) 308-2492

Form PCT/ISA/210 (second sheet)(July 1992)*

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US96/20040

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5,437,174 A (AYDIN) 01 August 1995 (01/08/95), entire document.	1-4
A	US 5,181,403 A (LII) 26 January 1993 (26/01/93), entire document.	4
A	US 3,812,403 A (GARTNER) 21 May 1974 (21/05/74), entire document.	1-4